APPLICATION OF PROSPECT THEORY TO MANAGEMENT DECISIONS UNDER RISK ON CONSTRUCTION PROJECT

ICSC’15
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INTRODUCTION

• How are we making decisions?

Using our beliefs  Using our judgement

Solid reasoning
INTRODUCTION

Expected Monetary Value

\[
EV(x_1, p_1; \ldots; x_n, p_n) = p_1 x_1 + \cdots + p_n x_n
\]

\[
p_1 + \cdots + p_n = 1
\]
PROSPECT THEORY

\[ EU(x_1, p_1; \ldots; x_n, p_n) = \pi(p_1)v(x_1) + \ldots + \pi(p_n)v(x_n) \]
QUESTIONNAIRE

Behavioural Tendencies
- Perception of Change
- Certainty Effect
- Non Compliance
- Loss Aversion

Cost Performance
- Under Budget
- On Budget
- Over Budget

Expected Values
- Expected Values Equal
- Expected Values different
DESCRIPTION OF THE SAMPLE

Gender:
- Men: 50 participants
- Women: 3 participants

Location:
- Ontario: 31 participants
- Michigan: 7 participants
- Texas: 6 participants
- Other US State: 6 participants
- Other country: 3 participants

Position:
- Executive: 5 participants
- Project Manager: 31 participants
- Foreman: 17 participants

Age:
- [20;25]: 4 participants
- [25;30]: 8 participants
- [30;35]: 6 participants
- [35;40]: 5 participants
- [40;45]: 9 participants
- [45;50]: 8 participants
- [50;55]: 5 participants
- [55;60]: 4 participants

Years of experience:
- [0;10]: 20 participants
- [10;20]: 8 participants
- [20;30]: 14 participants
- [30;40]: 11 participants
EXAMPLE

**Behavioral Tendencies**
- Perception of Change
- Certainty Effect
- Non Compliance
- Loss Aversion

**Cost Performance**
- Under Budget
- On Budget
- Over Budget

**Expected Values**
- Expected Values Equal
- Expected Values different

*Question 15:*
You are working on a project which is on time and on budget.

We need to install many shingles, and there are 2 types of shingles A and B which match the specifications. Which shingle type are you going to use?

- A
- B
RESULTS EV EQUAL

<table>
<thead>
<tr>
<th>A (Risk Taking)</th>
<th>B (No Risk)</th>
<th>Interval (95% confidence)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>Percentage</td>
<td>EV</td>
</tr>
<tr>
<td>On Budget</td>
<td>15</td>
<td>36%</td>
</tr>
</tbody>
</table>

- Participants are mainly Risk Avoiding
- Project cost performance has an impact on the results
<table>
<thead>
<tr>
<th>Q</th>
<th>Percentage</th>
<th>EV</th>
<th>Percentage</th>
<th>EV</th>
</tr>
</thead>
<tbody>
<tr>
<td>On Budget</td>
<td>2</td>
<td>72%</td>
<td>-$168</td>
<td>28%</td>
</tr>
</tbody>
</table>

**Interval (95% confidence)**: +/- 12%

- Participants are mainly Risk Taking
- No influence of the cost performance
- Still 35% of the participants are Risk avoiding
COMPUTATION OF THE EU

Decision Trees

<table>
<thead>
<tr>
<th>Shingle A</th>
<th>Shingle B</th>
</tr>
</thead>
<tbody>
<tr>
<td>3%</td>
<td>97%</td>
</tr>
<tr>
<td>-$200</td>
<td>-$194</td>
</tr>
<tr>
<td>-$200</td>
<td>-$200</td>
</tr>
</tbody>
</table>

EV

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>3%</td>
<td>97%</td>
</tr>
<tr>
<td>-$167</td>
<td>-$162</td>
</tr>
<tr>
<td>-$207</td>
<td>-$207</td>
</tr>
</tbody>
</table>

EU1

<table>
<thead>
<tr>
<th>Shingle A</th>
<th>Shingle B</th>
</tr>
</thead>
<tbody>
<tr>
<td>3%</td>
<td>97%</td>
</tr>
<tr>
<td>-$200</td>
<td>-$200</td>
</tr>
<tr>
<td>-$207</td>
<td>-$207</td>
</tr>
</tbody>
</table>

EU2

<table>
<thead>
<tr>
<th>Shingle A</th>
<th>Shingle B</th>
</tr>
</thead>
<tbody>
<tr>
<td>3%</td>
<td>97%</td>
</tr>
<tr>
<td>-$200</td>
<td>-$200</td>
</tr>
<tr>
<td>-$207</td>
<td>-$207</td>
</tr>
</tbody>
</table>

Results

<table>
<thead>
<tr>
<th>Shingle A</th>
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</tr>
</thead>
<tbody>
<tr>
<td>3%</td>
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</tr>
<tr>
<td>-$200</td>
<td>-$200</td>
</tr>
<tr>
<td>-$207</td>
<td>-$207</td>
</tr>
</tbody>
</table>

36% 64% 72% 28%

-$210  $23  $52

-$252  -$200  -$200

-$223  -$186  -$210

-$223  -$186  -$210

-$200  -$200  -$200

-$200  -$200  -$200

-$167  -$186  -$210

-$167  -$186  -$210

-$171  -$167  -$165

-$171  -$167  -$165

-$207  -$207  -$207
CONCLUSION

• Application of Behavioural Economics

  » Risk-Avoiding Behaviour
  » Influence of the Project Cost Performance
  » Influence of the decision-makers experience

→ Creation of small losses
THANK YOU!
COMPUTATION OF THE EU

\[ EU(x_1, p_1; \ldots; x_n, p_n) = \pi(p_1)\nu(x_1) + \ldots + \pi(p_n)\nu(x_n) \]

The first scale, \( \pi \):
Following the PT the scale \( \pi \) increases the probability of the risk:
- EU1: +10%
- EU2: +20%

The second scale, \( \nu \):
Outcomes are close to each other so the scale \( \nu \) is removed to simplify this computation

\[ EU_1 = (p_1 - 0.1)x_1 + (p_2 + 0.1)x_2 \]
AGE COMPARISON

<table>
<thead>
<tr>
<th>&lt; 45 years old</th>
<th>A (Risk Taking)</th>
<th>B (No Risk)</th>
<th>Interval (95% confidence)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q</td>
<td>Percentage</td>
<td>EV</td>
</tr>
<tr>
<td>Under Budget</td>
<td>6</td>
<td>19%</td>
<td>-$150</td>
</tr>
<tr>
<td>On Budget</td>
<td>15</td>
<td>30%</td>
<td>-$200</td>
</tr>
<tr>
<td>Over Budget</td>
<td>20</td>
<td>44%</td>
<td>-$300</td>
</tr>
</tbody>
</table>

- Least experienced participants are more Risk Averse
- Cost performance has an important impact on the results
**AGE COMPARISON**

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<td>Q</td>
<td>Percentage</td>
<td>EV</td>
<td>Percentage</td>
<td>EV</td>
</tr>
<tr>
<td><strong>Under Budget</strong></td>
<td>6</td>
<td>31%</td>
<td>-$150</td>
<td>69%</td>
</tr>
<tr>
<td><strong>On Budget</strong></td>
<td>15</td>
<td>42%</td>
<td>-$200</td>
<td>58%</td>
</tr>
<tr>
<td><strong>Over Budget</strong></td>
<td>20</td>
<td>62%</td>
<td>-$300</td>
<td>38%</td>
</tr>
</tbody>
</table>

- Most experienced participants are more Risk Taking
- Cost performance has an important impact on the results